Magneto-Hydrodynamic Simulations of Edge Localized Modes in ASDEX Upgrade

M. Hölzl[1], I. Krebs[1], K. Lackner[1], S. Günter[1], G. Huysmans[2], R. Wenninger[3], and the ASDEX Upgrade Team[1]
[1]Max-Planck-Institut für Plasmaphysik, EURATOM Association, Boltzmannstraße 2, 85748 Garching, Germany
[2]ITER Organisation, Route de Vinon sur Verdon, St-Paul-lez-Durance, France
[3] Universitätssternwarte der Ludwig-Maximilians-Universität, 81679 München, Germany

In the tokamak high confinement mode, large pressure gradients and current densities form close to the plasma boundary and render so-called edge localized modes (ELMs) unstable. As these instabilities have the potential of damaging wall structures in the next-generation tokamak experiment ITER, a detailed understanding of the underlying physics and of ways to control them is necessary.
We use the non-linear magneto-hydrodynamic code JOREK [1, 2] to study ELMs in realistic tokamak X-point geometry. Good agreement is obtained for toroidal mode numbers, poloidal filament sizes, and radial propagation speeds of filaments into the scrape-off layer with observations for type-I ELMs in the tokamak experiment ASDEX Upgrade. A strong localization of the simulated instabilities is found [3] when a large number of toroidal harmonics is taken into account. A similar structure was observed experimentally in ASDEX Upgrade [4].
In the simulations, harmonics with low toroidal mode-numbers may be driven non-linearly to energy levels comparable to those of the linearly most unstable harmonics. This effect is observed already in the early phase of the instability and can be explained by an interaction between several strong harmonics with adjacent toroidal mode numbers [3, 5].
An outlook onto some ongoing work is given. This includes a more sophisticated theory-experiment comparison and the interaction between edge localized modes and external perturbation fields. Additionally, the resistive wall model currently being implemented into JOREK [6] via a coupling to the STARWALL code [7] is briefly presented.

References

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